ELECTRICAL CONDUCTIVITY OF SYNTHESIZED ZIRCON CERAMICS DOPED WITH DIFFERENT DOPANTS

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The electrical conductivity enhancement of laboratory synthesized zircon ceramics, doped with different dopants has been studied using complex impedance spectroscopy. The cation dopants used in this study were Y^{3+}, Fe^{3+}, Yb^{3+}, Mg^{2+}, Ca^{2+}, Na^{+}, Er^{3+}, $Na^{+}+Y^{3+}$ and $Na^{+}+ Fe^{3+}$. It is expected, that the presence of defects in the zircon host structure introduced by doping can lead to higher electrical conduction.

First, X-Ray Diffraction (XRD) analysis was performed on the zircon samples doped with different cations to find out whether zircon formation was successful. Then, the complex impedance measurements were performed as a function of temperature.

The XRD analysis shows that, the formation of zircon was successful in the samples doped with 10 mol % Y_2O_3, 10 mol % Fe_2O_3, 10 mol % Yb_2O_3, 10 mol % MgO, 10 mol % CaO and 10 mol % Er_2O_3. The electrical conductivity of synthesized zircon ceramics increased with increasing temperature irrespective of the dopant. A good conductivity enhancement was obtained in zircon doped with 10 mol % Y_2O_3 and 10 mol % Fe_2O_3 which were 2.47×10^{-5} S cm^{-1} and 1.33×10^{-5} S cm^{-1} at 700 °C respectively. These values are nearly equal to the data reported in literature for natural zircon.

The conductivity enhancement in zircon samples doped with Y_2O_3 and Fe_2O_3 is most probably due to the motion of O^{2-} ions by vacancy mechanism. The O^{2-} ion vacancies were created as a consequence of the substitution of Y^{3+} and Fe^{3+} for Zr^{4+} or Si^{4+}. For substitution to take place the ions must be comparable in size. This indicates that, the ionic radii of Y^{3+} and Fe^{3+} are comparable to that of Zr^{4+} or Si^{4+}. However, the zircon samples doped with Yb_2O_3, MgO, CaO and Er_2O_3 did not show any significant conductivity enhancement. This may be due to non-incorporation of these dopants into the host structure of zircon to give a defect structure as a result of the difference in ionic radii of the cations. Hence, O^{2-} vacancies were not created and the conductivity was not increased.